

Citation for published version:

Mitchell, S, Haase, AM, Cumming, S & Malina, RM 2017, 'Understanding growth and maturation in the context of ballet: A biocultural approach', *Research in Dance Education*, vol. 18, no. 3, pp. 291-300.
<https://doi.org/10.1080/14647893.2017.1387525>

DOI:

[10.1080/14647893.2017.1387525](https://doi.org/10.1080/14647893.2017.1387525)

Publication date:

2017

Document Version

Peer reviewed version

[Link to publication](#)

This is an Accepted Manuscript of an article published by Taylor and Francis in *Research in Dance Education* on 09/10/2017, available online <http://www.tandfonline.com/10.1080/14647893.2017.1387525>.

University of Bath

Alternative formats

If you require this document in an alternative format, please contact:
openaccess@bath.ac.uk

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

UNDERSTANDING GROWTH AND MATURATION IN THE CONTEXT OF BALLET:
A BIOCULTURAL APPROACH

Understanding growth and maturation in the context of ballet: A biocultural approach

Siobhan B. Mitchell ^a, Anne M. Haase ^b, Sean P. Cumming ^a, Robert M. Malina ^c,

^aUniversity of Bath

^bUniversity of Bristol

^cUniversity of Texas at Austin

Author Note

Research conducted by Siobhan. B. Mitchell, MRes, MSc, Department for Health, University of Bath, Claverton Down, Bath, BA2 7AY, United Kingdom, S.B.Mitchell@bath.ac.uk

Anne M. Haase, PhD, School for Policy Studies, University of Bristol, 8 Priory Road, Bristol, BS8 1TZ, United Kingdom, Anne.Haase@bristol.ac.uk

Sean P. Cumming, PhD, Department for Health, University of Bath, Claverton Down, Bath, BA2 7AY, United Kingdom, S.Cumming@bath.ac.uk

Robert M. Malina, Professor Emeritus, Department of Kinesiology and Health Education, University of Texas, Stop D3700, Austin, TX 78712-1415, United States,

rmalina@lskyconnect.net

Address for correspondence: Siobhan. B. Mitchell, Department for Health, University of Bath, Claverton Down, Bath, BA2 7AY, United Kingdom, Tel. (+44) 7428 636586, Email. S.B.Mitchell@bath.ac.uk

Acknowledgements: Siobhan Mitchell is a doctoral student sponsored by the Economic and Social Research Council through the South West Doctoral Training Centre.

Abstract

The pubertal transition can present an interesting paradox for the young dancer, with growth and maturation leading to improvements in some areas such as strength and power and detriment to others, such as flexibility and co-ordination. These challenges highlight the need to consider the interactions among biological, psychological and sociocultural factors during the pubertal transition in the context of the ballet environment. Awareness of these potential interactions will likely provide insights as to why some dancers successfully adapt to the challenges of puberty while others have greater difficulty. This review explores how we might extend existing biocultural models to the context of ballet in order to garner a greater understanding of the pubertal transition. Future research should explore the interactions among social, psychological and biological factors during puberty in adolescent ballet dancers in order to document important determinants of adaptive responses at puberty and to inform future endeavours aimed at promoting healthy pubertal transitions among young dancers.

Key words: puberty, dance, teaching, growth, maturation, biocultural

Understanding growth and maturation in the context of ballet: A biocultural approach

The pubertal transition can present an interesting paradox for the young dancer. On the one hand, the dancer can benefit from improvements in strength, power and motor performance associated with growth and maturation. The activation of new motivational tendencies (i.e., greater desire to seek out social goals and rewards) also encourages the young dancer to explore and engage with their social environments, which provides learning experiences *per se* and facilitates the acquisition of more sophisticated knowledge and skills. On the other hand, seemingly sudden changes in body shape and size associated with puberty may temporarily disrupt flexibility and co-ordination, resulting in poorer motor performances and enhanced risk of injury (Daniels *et al.*, 2001). Greater self-consciousness and social anxieties associated with the morphological changes may place the dancer at enhanced risk for affective disorders, specifically related to physical characteristics and performance, e.g., body dysmorphic disorders and eating disorders (Forbes & Dahl, 2010). The preceding highlights the need to consider the interactions among biological, psychological and sociocultural factors during the pubertal transition in the context of the ballet environment. Awareness of these potential interactions will likely provide insights as to why some dancers successfully adapt to the challenges of puberty while others have greater difficulty.

How young dancers interpret the physical and physiological changes that occur during puberty is influenced, to a large extent, by social context, while the perceived desirability of the changes is influenced by gender and dance style. In the social context of ballet, pubertal changes in size, strength and power are likely welcomed for boys, but are often viewed as detrimental for girls as the changes often modify physique, shifting it away from a largely

prepubescent model valued by the ballet community (Buckroyd, 2000, Pickard, 2012). With these challenges in mind, this paper focuses on the young female ballet dancer.

The experiences of young ballet dancers during the pubertal transition have not been widely explored. Dance teachers often perceive this interval as a ‘make or break’ or pivotal event for young dancers. Some have described puberty as “very inconvenient but inevitable sadly” and akin to Russian roulette (Mitchell *et al.*, 2016), where even the most talented dancers struggle during this biological and behavioural transition of youth.

“As a professional, that’s the scariest thing to experience—your body changing—because that’s your tool. That’s your instrument and when it becomes unfamiliar, you don’t know how to work with it. So it was extremely difficult to experience puberty and my body changing at such a late age, 19, when I was already a professional. It took me years of listening to other people’s words, and accepting advice about how to really treat it like the instrument that it is, to learn.” (Copeland, 2014, no pagination) *Misty Copeland, 2014*

A biocultural approach

The majority of research looking at the implications of puberty in dance focusses on issues related to performance and injury, and to a lesser extent on psychological issues and related factors. Except for variation in the timing of puberty (Brooks-Gunn *et al.*, 1989, Brooks-Gunn & Warren, 1985), however, the biological changes that accompany puberty in dancers have been largely neglected. Of relevance, several factors may influence the degree to which

puberty is viewed positively or negatively in the context of ballet, i.e., the sociocultural - the extent to which the physical changes associated with puberty conform to expectations for a particular style of dance, the psychological – self-esteem and body satisfaction, and the biological – the timing of puberty *per se* and relative to peers.

It is essential that the sociocultural, psychological and biological dimensions of puberty be integrated into a biocultural perspective (Cumming *et al.*, 2012, Malina *et al.*, 2004, Malina *et al.*, 2016). A biocultural perspective not only recognises the influence of biological, psychological and sociocultural factors, but more importantly considers the manner in which the factors interact to impact the experiences of dancers as they progress through the pubertal transition (McElroy, 1990). Such an approach would seemingly help young dancers to successfully adjust to the challenges of puberty, to thrive in the dance environment, and to minimize the risk of dropping out. Adopting a biocultural perspective, one can argue, can positively influence how the young dancer interprets and manages changes associated with the pubertal transition, and also the reactions and evaluations of significant others - peers, instructors, parents. The basic premise of an integrative biocultural model is illustrated in figure 1.

A biocultural approach also provides an ideal framework for understanding individual differences in pubertal timing. Girls who mature earlier or later compared to peers, experience and must adapt to different challenges. A dancer who matures in advance of her peers, for example, spent less time in childhood and has had to adapt to the pubertal changes at an earlier age. As cognitive and social development is dependent upon age and experience, and not biology *per se*, dancers who mature in advance of peers are perhaps less prepared to

deal with the challenges of puberty and as a result may have more negative experiences in the dance environment. Not surprisingly, ballet dancers who mature early have a higher risk of drop out (voluntary and/or systematic as selection out of full-time training) and are more vulnerable to experiencing psychosocial issues related to low self-esteem, body dissatisfaction and disordered eating (Brooks-Gunn & Warren, 1985, Hamilton *et al.*, 1997). In contrast, dancers who attain puberty later not only tend to have, on average, a physique perceived as more amenable to success in ballet, but may enter puberty at a more advanced stage of cognitive and social development associated with chronological age *per se* (Blakemore, 2014, Blakemore *et al.*, 2010). Dancers who mature later, however, may experience challenges associated with an increased training load and stresses during the period of rapid growth and may be at greater risk of injury.

A biocultural perspective also provides dance instructors and practitioners with a framework within which to better manage the experiences of young dancers working under their supervision and tutelage. Whereas the timing of puberty can differentially impact the self-perceptions of young dancers, the extent to which these associations are realised is impacted to a large extent by the evaluations and reactions of dance teachers, peers and parents (Mitchell *et al.*, 2016). Teachers cognizant of the biological and behavioural aspects of normal pubertal development and associated inter-individual variation may, for example, encourage dancers to view puberty as a normal and attractive step in becoming an adult, and provide an understanding and supportive environment. Through educating the young dancers and adjusting training demands to individual differences, the teacher may help the aspiring dancer to overcome challenges and to optimise both development and safety.

Direct and Indirect effects

Biocultural approaches to the study of adaptations during puberty have generally subscribed to direct and indirect paradigms. Direct effect models have become less popular in psychology but may have more relevance to dance and physical activity. Accordingly, the biological processes underlying puberty not only effect physical and physiological changes, but also exert a direct impact upon behaviours. Such models view the effects of puberty on behaviours as universal and perhaps inescapable. A direct effect model would posit that decrements in flexibility and co-ordination are a result of underlying changes in biology – differential growth in skeletal lengths and associated soft tissues. While direct effect models may explain some of the effects of pubertal changes on performance and brain development, the models have limitations in explaining the complex psychological and social changes associated with puberty, e.g., changes in body image and motivation. Direct effects models obviously do not account for perceptions and expectations of others as well as inter-personal interactions.

Indirect effect models, in contrast, describe the influence of puberty through personal and external factors. For example, feelings of self-confidence during puberty may be indirectly affected by both personal and interpersonal factors. Personal or mediating factors influence how the individual perceives her/his pubertal changes, while external or moderating factors influence how overt pubertal changes are perceived and evaluated by significant others. Pubertal youth also interact within many social contexts – society in general, the family, school, the ballet studio, peer groups, among others; each context is an external or moderating factor which presents different challenges. The social context of ballet and

especially the dance teacher and dance peers are important moderating factors for the young dancer. The social context of a ballet studio may, for example, influence the psychological impact of pubertal changes in physique. If the studio or teacher specifies a specific physique as the norm, this may affect how a young dancer perceives and responds to the changes that occur with puberty. On the other hand, if the studio or teacher accepts inter-individual variability, the pubertal changes will be viewed positively and will likely reduce the risk of negative outcomes and of dropping-out. These types of relationships among other factors are central to the indirect or mediated effect models.

Many mediating factors are endogenous; they represent factors that originate from the individual dancer's personality and/or value system. Factors such as self-esteem, self-concept and internalised feelings about the body, and meanings attached to bodily processes and pubertal changes are generally considered endogenous (Cumming *et al.*, 2011, Petersen & Taylor, 1980). Although considered endogenous, physical self-concept and internalised thoughts and feelings about the body and meanings attached to pubertal changes are shaped by cultural expectations and social contexts (Pickard, 2013). Moreover, individual psychological adaptations to the timing of puberty and associated changes may influence health and well-being outcomes (Petersen & Taylor, 1980).

Cultural and social factors, which are external to the individual, are important moderators of individual adaptations to pubertal change. Factors within a young dancer's immediate social context include objects of the physical environment such as mirrors and dancewear, the atmosphere of the studio, and of course the teacher and peers. The environment or more appropriately the "culture" of a specific studio is established by the adults – teachers and

other involved adults. Influencing factors include culturally shared beliefs, attitudes or perceptions concerning puberty *per se* and early or late maturation; cultural standards of attractiveness; and notions of desirable and undesirable physical development (Petersen & Taylor, 1980). Within the social and specific “cultural” contexts of ballet, later maturation may be seen as the norm for females, so that attitudes towards later maturation may be favourable due to the likelihood of maintaining a slimmer and more suitable physique (Brooks-Gunn & Warren, 1985, Mitchell *et al.*, 2016). These moderating factors have been generally overlooked and are especially lacking in the context of dance, where focus on performance and evaluation makes these moderating factors especially important.

Extending current biocultural models

A biocultural model of pubertal adaptation in ballet among adolescent girls must recognise the potential for both direct and indirect factors. The model provides an ideal framework for understanding the wider impact of puberty upon ballet aspirants and the various mechanisms and processes which underlie the effects. The biocultural model addresses the complexity of biological maturation as comprising several different processes, including the timing of pubertal changes, morphological changes (development of secondary sex characteristics, associated changes in body size, shape and composition) and the development of adult reproductive capacity (e.g. menarche, subsequent menstrual cycles and regular ovulation). The biological changes characteristic of pubertal maturation and growth likely interact with the behavioural characteristics of the individual and of course the context of ballet in different ways. For example, overt breast development may not only influence the young dancer but may also impact evaluations of others. These interactions and others may in turn influence

the learning experiences of the dancer and subsequent behavioural and perhaps health outcomes (Annus & Smith, 2009, Summers-Effler, 2004).

Two hypotheses deriving from developmental psychology are relevant in the context of ballet – the Puberty-Initiated Mediation hypothesis (Ge & Natsuaki, 2009) and the Contextual Amplification hypothesis (Ge *et al.*, 2002). The former suggests that physical and functional characteristics related to variation in the timing of puberty hold social stimulus value for important others such as educators, peers and parents, and thus influence their perceptions of the individual and the nature and quality of social interactions with her (Ge & Natsuaki, 2009). The concept of social stimulus value describes the interactions among adolescent bodily changes, personality and sociocultural variables; the social stimulus value of the physical changes depends on the social context in which they occur (Petersen & Taylor, 1980). For example, the body size and shape of a female dancer influence teacher evaluation of current ability and future potential (Mitchell *et al.*, 2016).

Within the social context of ballet training where a linear physique is desired (Vincent, 1981), later maturation and associated physical characteristics hold a more positive social stimulus value for ballet teachers and peers than physical characteristics associated with stockiness in build which are more pronounced with early maturation (Brooks-Gunn & Warren, 1985, Pickard, 2013). Moreover, ballet teachers perceived early maturing girls less positively; specific changes associated with early maturation such as widening of the hips, enhanced breast development and increase in fat stores were generally viewed as not ‘conducive’ to a career in ballet. In contrast, ballet teachers perceived late maturing girls more positively in terms of their physical characteristics and potential for a career in ballet (Mitchell *et al.*,

2016). Similar findings have been noted among high school female artistic gymnasts. Girls who were taller, heavier and carrying greater weight-for-height perceived their coaches as less likely to engage in positive coaching behaviours such as reinforcement, encouragement and instruction and as more likely to engage in negative coaching behaviours such as punitive technical instruction and punishment (Cumming *et al.*, 2005). Corresponding data are not available for elite artistic gymnasts who are characteristically short and late maturing (Malina *et al.*, 2013). Although the Puberty-Initiated Mediation hypothesis is seemingly logical and consistent with limited observations, it requires further validation, particularly in the context of ballet. To this end, longitudinal observations on dancers beginning in the transition into and through puberty are needed.

The Contextual Amplification hypothesis (Ge *et al.*, 2002), on the other hand, suggests that the negative effects of puberty are accentuated in contexts which are aversive, especially in early maturing girls (Allison & Hyde, 2013, Ge *et al.*, 2002). Applied to ballet, the hypothesis suggests that an early maturing dancer who experiences visible changes in physique such as increased fat mass, widening of the hips and breast development, will have negative experiences during puberty. More specifically, training for long hours in a learning environment which emphasises thinness would increase the likelihood of maladaptive responses in a pubertal dancer such as issues with body image and self-esteem. A comparison of dance and non-dance students 14-18 years, suggested that the social context of ballet amplified the effects of maturational timing (age at menarche) and had consequences for health and wellbeing. Early and on-time maturation within the context of dance training resulted in higher incidences of disordered eating than in early and on-time non-dance students (Brooks-Gunn & Warren, 1985). The authors hypothesized that effects of

maturational timing may be moderated by the social context, cultural beliefs and individual beliefs about the importance of behaviours associated with maturation (Brooks-Gunn & Warren, 1985). Given the cultural expectation of thinness in ballet, later maturation is deemed advantageous for dancers; it is associated with desirable attributes such as a lower body weight, lower concerns about weight, and control over eating (Brooks-Gunn & Warren, 1985, Vincent, 1981).

Although data are somewhat limited, there is increasing support of the notion that the effects of maturational timing may be greater in the context of ballet and other aesthetic disciplines such as artistic and rhythmic gymnastics and figure skating. It is often assumed that on-time and late maturing ballet dancers may differ more in terms of psychosocial outcomes than on-time and late non-dancers (Brooks-Gunn *et al.*, 1989); late maturing dancers exhibit more desirable physical and psychological attributes than those dancers who are on-time in maturation (Brooks-Gunn & Warren, 1985). Within this particular social context, where it is an expectation for dancers to mature late, while those who mature on-time may experience the same psychological disadvantages as early maturing individuals in non-dance populations. Ballet dancers who are on-time or average in maturation rated themselves as heavy and expressed a desire to lose weight even though they were below the ideal weight or their age and had higher dieting and bulimia scores. In contrast, non-dancers who were on-time had the most positive body image and fewer psychosocial issues (Brooks-Gunn & Warren, 1985). The findings are generally consistent with the Contextual Amplification hypothesis (Ge *et al.*, 2002), suggesting that social context acts as a moderator between maturation timing and problematic behaviours in dance, e.g., negative body image and disordered eating.

Some recent evidence, limited to an interview survey of 10 ballet teachers (Mitchell *et al.*, 2016), provides further support for the Contextual Amplification hypothesis. Ten ballet teachers were interviewed to explore how they perceived and valued the adolescent body in dance. The approaches of the teachers to managing puberty within the context of ballet ranged from direct to indirect to passive. Direct approaches focussed on an open dialogue with student dancers with actions such as adjusting aspirations to fit with the outcomes of puberty. Indirect approaches accommodated pubertal changes through actions such as the removal of studio mirrors. Consistent within the contextual amplification hypothesis, these approaches have the potential to create a protective environment in the dance studio whereby the teacher acts as a moderator between the maturity-related factors and the social context of the ballet world. In contrast, a passive approach does not accommodate variation in pubertal timing and associated changes within the dance studio and is likely to be consistent with intensifying the effects of variation in maturation timing among dancers. The preceding is limited to ballet teacher perceptions and values regarding adolescent changes. Further research is needed to substantiate the influence of different teaching approaches in mitigating potentially negative effects reflected in problem behaviours or health issues.

The study of ballet teachers is generally consistent with the assertion that the potential effects of variation in maturational timing are moderated by the social and cultural context and individual beliefs about the importance of behaviours associated with maturation (Brooks-Gunn & Warren, 1985). Although ballet teachers had mixed opinions about the potential advantages of individual differences in pubertal timing (early, on time or late), the findings emphasize that the social context of the ballet “culture” is central to viewing pubertal changes

as positive or negative (Mitchell *et al.*, 2016). This “culture” was viewed by the teachers as something that they were not able to change! While the teachers could positively evaluate pubertal changes and adjust individual aspirations accordingly, they could not alter the way in which physical changes associated with puberty and the body of the adolescent dancer were viewed by the wider dance world (Mitchell *et al.*, 2016).

Allowing for the limitations of the available data, support for biocultural models is increasing in studies of sport, physical activity and movement proficiency (Cumming *et al.*, 2012, Cumming *et al.*, 2011, Hunter Smart *et al.*, 2012, Malina *et al.*, 2016). Few studies to date have actively considered a biocultural perspective within the context of ballet. Nevertheless, an indirect relationship between maturity status and physical activity moderated via physical self-concept has been noted (Cumming *et al.*, 2011). The mediated effects model functioned to identify physical self-concept as a potential mechanism through which reduced physical activity levels of early maturing girls can be targeted. Another study explored relationships among maturity status, physical activity, physical self-concept and health-related quality of life and noted an association between early maturation in adolescent females and reduced involvement in physical activity, and a potential role for physical self-concept in mediating the relationship between maturity status and physical activity (Hunter Smart *et al.*, 2012).

Future Directions in the study of ballet

Although biocultural models may apply to the domain of ballet, the complex interactions between mediating and moderating factors which may affect the adolescent dancer have yet to be fully explored. Future research should explore the interactions among social,

psychological and biological factors during puberty in adolescent ballet dancers in order to document important determinants of adaptive responses at puberty and to inform future endeavours aimed at promoting healthy pubertal transitions among young dancers.

Future research should take into account the key role of the ballet teacher in creating healthy and adaptive environments for young dancers, as well as provide a better understanding of the relationships between ballet teachers and young dancers during adolescence in an effort to enhance health and well-being. Both ballet students and teachers need attention. Central to these efforts should be enhanced opportunities for the further education of teachers on underlying concepts of physical growth, biological maturation, and behavioural development of youth. An important corollary is the promotion of a more open dialogue with adolescent dancers regarding puberty and associated changes in an effort to better equip them in coping with the associated changes in the context of the challenging ballet environment. To these objectives, there is a need for critical evaluation of available methods for the assessment of maturity status and timing (Malina, in press) in an effort to improve their application in the context of the ballet environment. This may function to assist dance schools and teachers to guide young dancers through this challenging phase of talent development and to ensure that teachers and staff are equipped to interpret and utilise this information to guide aspiring dancers in a developmentally sensitive and appropriate manner.

Innovative teaching and training strategies merit attention. Bio-banding, for example, is a concept which has been applied in the sport context, specifically soccer. Bio-banding takes into account individual differences in growth and maturation in an effort to address challenges for talented late and early maturing players (Cumming *et al.*, in press). It may be

UNDERSTANDING GROWTH AND MATURATION IN THE CONTEXT OF BALLET:

A BIOCULTURAL APPROACH

worthwhile to explore the application of training strategies such as bio-banding and whether we could apply some of the same principles to working with ballet dancers during the transition into puberty. Such an approach may contribute to more developmentally appropriate training programmes that accommodate individual differences in biological maturation.

Acknowledgements: Siobhan Mitchell is a doctoral student sponsored by the Economic and Social Research Council through the South West Doctoral Training Centre.

Word count: 3549

References

- Allison, C. M. & Hyde, J. S. (2013) Early menarche: Confluence of biological and contextual factors. *Sex Roles*, 68(1-2), 55-64.
- Annus, A. & Smith, G. T. (2009) Learning experiences in dance class predict adult eating disturbance. *European Eating Disorders Review*, 17(1), 50-60.
- Blakemore, S.-J. (2014) Brain development in adolescence. *Journal of Neurology, Neurosurgery & Psychiatry*, 85(8), e3-e3.
- Blakemore, S. J., Burnett, S. & Dahl, R. (2010) The role of puberty in the developing adolescent brain. *Hum. Brain Mapp.*, 31(6), 926-933.
- Brooks-Gunn, J., Attie, I., Burrow, C., Rosso, J. T. & Warren, M. P. (1989) The impact of puberty on body and eating concerns in athletic and nonathletic contexts. *The Journal of Early Adolescence*, 9(3), 269-290.
- Brooks-Gunn, J. & Warren, M. (1985) The effects of delayed menarche in different contexts: Dance and nondance students. *A Multidisciplinary Research Publication*, 14(4), 285-300.
- Buckroyd, J. (2000) *The student dancer: Emotional aspects of the teaching and learning of dance*, (London, Dance Books).
- Copeland, M. (2014) Youth, maturity, and physicality in new classical ballet, in: J. Ohikuafe (Ed.) (<http://www.theatlantic.com/health/archive/2014/03/youth-maturity-and-physicality-in-new-classical-ballet/284558/>, The Atlantic).
- Cumming, S. P., Eisenmann, J. C., Smoll, F. L., Smith, R. E. & Malina, R. M. (2005) Body size and perceptions of coaching behaviors by adolescent female athletes. *Psychology of Sport and Exercise*, 6(6), 693-705.
- Cumming, S. P., Lloyd, R. S., Oliver, J. L., Eisenmann, J. C. & Malina, R. M. (in press) Bio-banding in sport: Applications to competition, talent identification, and strength and conditioning in youth athletes. *Strength and Conditioning Journal*.
- Cumming, S. P., Sherar, L., Pindus, D., Coelho-E-Silva, M., Malina, R. M. & Jardine, P. (2012) A biocultural model of maturity-associated variance in adolescent physical activity. *International Review of Sport and Exercise Psychology*, 5(1), 23-43.
- Cumming, S. P., Standage, M., Loney, T., Gammon, C., Neville, H., Sherar, L. B. & Malina, R. M. (2011) The mediating role of physical self-concept on relations between

- biological maturity status and physical activity in adolescent females. *Journal of Adolescence*, 34(3), 465-473.
- Daniels, K., Rist, R. & Rijven, M. (2001) The challenge of the adolescent dancer. *Journal of Dance Education*, 1(2), 74-76.
- Forbes, E. E. & Dahl, R. E. (2010) Pubertal development and behavior: Hormonal activation of social and motivational tendencies. *Brain and cognition*, 72(1), 66-72.
- Ge, X., Brody, G. H., Conger, R. D., Simmons, R. L. & Murry, V. M. (2002) Contextual amplification of pubertal transition effects on deviant peer affiliation and externalizing behavior among african american children *Developmental Psychology*, 38(1), 42-54.
- Ge, X. & Natsuaki, M. (2009) In search of explanations for early pubertal timing effects on developmental psychopathology. *Current directions in psychological science*, 18(6), 327-331.
- Hamilton, L. H., Hamilton, W. G., Warren, M. P., Keller, K. & Molnar, M. (1997) Factors contributing to the attrition rate in elite ballet students. *Journal of dance medicine & science*, 1(4), 131-139.
- Hunter Smart, J., Cumming, S. P., Sherar, L., Standage, M., Neville, H. & Malina, R. M. (2012) Maturity associated variance in physical activity and health-related quality of life in adolescent females. A mediated effects model. *Journal of Physical Activity & Health*, 9(1), 86-95.
- Malina, R. M. (in press) Assessment of biological maturation, in: N. Armstrong & W. Van Mechelen (Eds) *Oxford textbook of children's exercise science and medicine*. (Oxford, Oxford University Press).
- Malina, R. M., Baxter-Jones, A., Armstrong, N., Beunen, G., Caine, D., Daly, R., Lewis, R., Rogol, A. D. & Russell, K. (2013) Role of intensive training in the growth and maturation of artistic gymnasts. *Sports Med*, 43(9), 783-802.
- Malina, R. M., Bouchard, C. & Bar-Or, O. (2004) *Growth, maturation and physical activity*, (Second Edition edn) (Champaign, IL, Human Kinetics).
- Malina, R. M., Cumming, S. P. & Coelho E Silva, M. J. (2016) Physical activity and movement proficiency: The need for a biocultural approach. *Pediatric exercise science*, 28(2).

UNDERSTANDING GROWTH AND MATURATION IN THE CONTEXT OF BALLET:

A BIOCULTURAL APPROACH

- Mcelroy, A. (1990) Biocultural models in studies of human health and adaptation. *Medical Anthropology Quarterly: International Journal for the Analysis of Health*, 4(3), 243-265.
- Mitchell, S. B., Haase, A. M., Malina, R. M. & Cumming, S. P. (2016) The role of puberty in the making and breaking of young ballet dancers: Perspectives of dance teachers. *Journal of Adolescence*, 47, 81-89).
- Petersen, A. & Taylor, B. (1980) The biological approach to adolescence: Biological change and psychosocial adaptation, in: J. Adelson (Ed.) *Handbook of adolescent psychology*. (New York, Wiley).
- Pickard, A. (2012) Schooling the dancer: The evolution of an identity as a ballet dancer. *Research in Dance Education*, 13(1), 25-46.
- Pickard, A. (2013) Ballet body belief: Perceptions of an ideal ballet body from young ballet dancers. *Research in Dance Education*, 14(1), 3-19.
- Summers-Effler, E. (2004) Little girls in women's bodies: Social interaction and the strategizing of early breast development. *Sex Roles*, 51(1-2), 29-44.
- Vincent, L. M. (1981) *Competing with the sylph: The pursuit of the ideal body form*, (UK, Berkley).

Figure captions

Figure 1. Basic biocultural model, adapted from McElroy (1990)

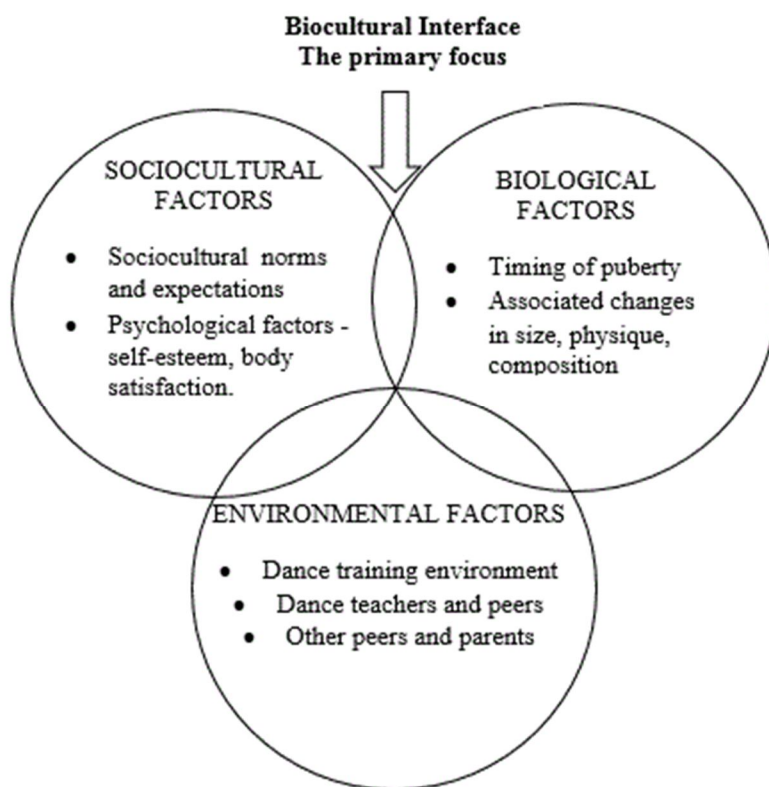


Figure 2. A biocultural model of maturity-associated variation in adolescent dancers, adapted for dance from Cumming et al, 2012.

